

may be reduced somewhat, as materials such as metal, plastic, and fiber-glass continue to be used in many products as alternatives to wood. Environmental measures designed to control various pollutants used in, or generated by, woodworking processes may also impact employment, especially in secondary industries, such as household furniture. Because of these trends, employment opportunities in primary wood industries could be more limited than those in secondary industries.

Employment in all woodworking occupations is highly sensitive to economic cycles; and during economic downturns, workers are subject to layoffs or a reduction in hours.

Earnings

Median annual earnings of wood machinists were \$19,980 in 1998. The middle 50 percent earned between \$16,170 and \$23,920. The lowest 10 percent earned less than \$13,380 and the highest 10 percent earned more than \$28,590. Median annual earnings in the industries employing the largest numbers of wood machinists in 1997 are shown below:

Millwork, plywood, and structural members .....	\$19,500
Household furniture .....	19,000

Median annual earnings of cabinetmakers and bench carpenters were \$22,390 in 1998. The middle 50 percent earned between \$17,870 and \$28,250. The lowest 10 percent earned less than \$14,260 and the highest 10 percent earned more than \$35,880. Median earnings in the industries employing the largest numbers of cabinetmakers and bench carpenters in 1997 are shown below:

Residential building construction .....	\$26,400
Partitions and fixtures .....	23,700
Carpentry and floor work .....	22,600
Millwork, plywood, and structural members .....	21,300
Furniture and homefurnishings stores .....	21,200
Household furniture .....	18,500

Median annual earnings of woodworking machine operators and tenders, setters and set-up operators were \$19,260 in 1998. The middle 50 percent earned between \$15,600 and \$22,910. The lowest

10 percent earned less than \$13,260 and the highest 10 percent earned more than \$27,060. Median annual earnings in the industries employing the largest numbers of woodworking machine operators and tenders, setters and set-up operators in 1997 are shown below:

Millwork, plywood, and structural members .....	\$19,500
Sawmills and planing mills .....	18,500
Household furniture .....	18,300
Miscellaneous wood products .....	17,000

Earnings vary by industry, geographic region, skill, educational level, and complexity of machinery operated. In 1998, median annual earnings were \$19,490 for head sawyers and sawing machine operators and tenders; \$19,880 for furniture finishers; and \$22,430 for all other precision woodworkers.

Some woodworkers, such as those in logging or sawmills, who are engaged in processing primary wood and building materials, are members of the International Association of Machinists. Others belong to the United Furniture Workers of America or the United Brotherhood of Carpenters and Joiners of America.

Related Occupations

Many woodworkers follow blueprints and drawings and use machines to shape and form raw wood into a final product. Workers who perform similar functions working with other materials include precision metalworkers, metalworking and plastics-working machine operators, metal fabricators, molders and shapers, and leather workers.

Sources of Additional Information

For information about woodworking occupations, contact local furniture manufacturers, sawmills and planing mills, cabinetmaking or millwork firms, lumber dealers, a local of one of the unions mentioned above, or the nearest office of the State employment service.

For general information about furniture woodworking occupations, contact:

- ✦ American Furniture Manufacturers Association, Manufacturing Services Division, P.O. Box HP-7, High Point, NC 27261.
- Internet: <http://www.afmahp.org>

Miscellaneous Production Occupations

Dental Laboratory Technicians

(O\*NET 89921)

Significant Points

- Employment should increase slowly, as the public's improving dental health requires fewer dentures but more bridges and crowns.
- Dental laboratory technicians need artistic aptitude for detailed and precise work, a high degree of manual dexterity, and good vision.

Nature of the Work

Dental laboratory technicians fill prescriptions from dentists for crowns, bridges, dentures, and other dental prosthetics. First, dentists send a specification of the item to be fabricated, along with an impression (mold) of the patient's mouth or teeth. Then dental laboratory technicians, also called dental technicians, create a model of the patient's mouth, by pouring plaster into the impression and allowing it to set. Next, they place the model on an apparatus that mimics the bite and movement of the patient's jaw. The model serves as the basis of the prosthetic device. Technicians examine the model, noting the size and

shape of the adjacent teeth, as well as gaps within the gumline. Based upon these observations and the dentist's specifications, technicians build and shape a wax tooth or teeth model, using small hand instruments called wax spatulas and wax carvers. They use this wax model to cast the metal framework for the prosthetic device.

Once the wax tooth has been formed, dental technicians pour the cast and form the metal, and using small hand-held tools, prepare the surface to allow the metal and porcelain to bond. They then apply porcelain in layers, to arrive at the precise shape and color of a tooth. Technicians place the tooth in a porcelain furnace to bake the porcelain onto the metal framework, then adjust the shape and color, with subsequent grinding and addition of porcelain to achieve a sealed finish. The final product is a near exact replica of the lost tooth or teeth.

In some laboratories, technicians perform all stages of the work, whereas in other labs, each technician does only a few. Dental laboratory technicians can specialize in one of five areas: Orthodontic appliances, crowns and bridges, complete dentures, partial dentures, or ceramics. Job titles can reflect specialization in these areas. For example, technicians who make porcelain and acrylic restorations are called *dental ceramists*.

Working Conditions

Dental laboratory technicians generally work in clean, well lighted, and well-ventilated areas. Technicians usually have their own workbenches, which can be equipped with Bunsen burners, grinding and



*A dental laboratory technician examines a patient's model, noting the size and shape of the adjacent teeth as well as gaps within the gumline.*

polishing equipment, and hand instruments, such as wax spatulas and wax carvers.

The work is extremely delicate and time consuming. Salaried technicians usually work 40 hours a week, but self-employed technicians frequently work longer hours.

### Employment

Dental laboratory technicians held about 44,000 jobs in 1998. Most jobs were in commercial dental laboratories, which usually are small, privately owned businesses with fewer than five employees. However, some laboratories are large; a few employ over 50 technicians.

Some dental laboratory technicians worked in dentists' offices. Others worked for hospitals providing dental services, including Department of Veterans Affairs' hospitals. Some technicians work in dental laboratories in their homes, in addition to their regular job. Approximately 1 technician in 5 is self-employed, a higher proportion than in most other occupations.

### Training, Other Qualifications, and Advancement

Most dental laboratory technicians learn their craft on the job. They begin with simple tasks, such as pouring plaster into an impression, and progress to more complex procedures, such as making porcelain crowns and bridges. Becoming a fully trained technician requires an average of 3 to 4 years, depending upon the individual's aptitude and ambition; but it may take a few years more to become an accomplished technician.

Training in dental laboratory technology is also available through community and junior colleges, vocational-technical institutes, and the

Armed Forces. Formal training programs vary greatly both in length and the level of skill they impart.

In 1998, 34 programs in dental laboratory technology were approved (accredited) by the Commission on Dental Accreditation in conjunction with the American Dental Association (ADA). These programs provide classroom instruction in dental materials science, oral anatomy, fabrication procedures, ethics, and related subjects. In addition, each student is given supervised practical experience in a school or an associated dental laboratory. Accredited programs normally take 2 years to complete and lead to an associate degree.

Graduates of 2-year training programs need additional hands-on experience to become fully qualified. Each dental laboratory owner operates in a different way, and classroom instruction does not necessarily expose students to techniques and procedures favored by individual laboratory owners. Students who have taken enough courses to learn the basics of the craft are usually considered good candidates for training, regardless of whether they have completed a formal program. Many employers will train someone without any classroom experience.

The National Board offers certification, which is voluntary, in five specialty areas: crowns and bridges, ceramics, partial dentures, complete dentures, and orthodontic appliances.

In large dental laboratories, technicians may become supervisors or managers. Experienced technicians may teach or take jobs with dental suppliers in such areas as product development, marketing, and sales. Still, for most technicians, opening one's own laboratory is the way toward advancement and higher earnings.

A high degree of manual dexterity, good vision, and the ability to recognize very fine color shadings and variations in shape are necessary. An artistic aptitude for detailed and precise work is also important. High school students interested in becoming dental laboratory technicians should take courses in art, metal and wood shop, drafting, and sciences. Courses in management and business may help those wishing to operate their own laboratories.

### Job Outlook

Job opportunities for dental laboratory technicians should be favorable, despite very slow growth in the occupation. Employers have difficulty filling trainee positions, probably because of relatively low entry-level salaries and lack of familiarity with the occupation.

Although job opportunities are favorable, little or no change in the employment of dental laboratory technicians is expected through the year 2008, due to changes in dental care. The overall dental health of the population has improved because of fluoridation of drinking water, which has reduced the incidence of dental cavities, and greater emphasis on preventive dental care since the early-1960s. As a result, full dentures will be less common, as most people will need only a bridge or crown. However, during the last few years, demand has arisen from an aging public that is growing increasingly interested in cosmetic prosthesis. For example, many dental laboratories are filling orders for composite fillings that are white and look like a natural tooth to replace older, less attractive fillings.

### Earnings

Median annual earnings of salaried precision dental laboratory technicians were \$25,660 in 1998. The middle 50 percent earned between \$19,410 and \$34,600 a year. The lowest 10 percent earned less than \$14,720 and the highest 10 percent earned more than \$45,980 a year. Median annual earnings of dental laboratory technicians in 1997 were \$24,100 in medical and dental laboratories and \$25,500 in offices and clinics of dentists.

In general, earnings of self-employed technicians exceed those of salaried workers. Technicians in large laboratories tend to specialize in a few procedures, and, therefore, tend to be paid a lower wage than those employed in small laboratories that perform a variety of tasks.

### Related Occupations

Dental laboratory technicians fabricate artificial teeth, crowns and bridges, and orthodontic appliances, following specifications and instructions

provided by dentists. Other workers who make medical devices include arch-support technicians, orthotics technicians (braces and surgical supports), prosthetics technicians (artificial limbs and appliances), opticians, and ophthalmic laboratory technicians.

### Sources of Additional Information

For a list of accredited programs in dental laboratory technology, contact:  
 ☛ Commission on Dental Accreditation, American Dental Association, 211 E. Chicago Ave., Chicago, IL 60611. Internet: <http://www.ada.org>

General information on grants and scholarships is available from dental technology schools.

For information on requirements for certification, contact:

☛ National Board for Certification in Dental Technology, 8201 Greensboro Dr., Suite 300, McLean VA 22101.

For information on career opportunities in commercial laboratories, contact:

☛ National Association of Dental Laboratories, 8201 Greensboro Dr., Suite 300, McLean VA 22101. Internet: <http://www.nadl.org>

## Electronic Semiconductor Processors

(O\*NET 92902A, 92902B, 92902C, 92902D, 92902E, and 92902G)

### Significant Points

- Electronic semiconductor processors is the only manufacturing occupation expected to grow much faster than the average for all occupations.
- A 1-year certificate in semiconductor technology is good preparation for semiconductor processor operator positions; for more highly skilled technician positions, an associate degree in electronics technology or a related field is necessary.

### Nature of the Work

Semiconductors—also known as computer chips, microchips, or integrated chips—are the miniature but powerful brains of high technology equipment. They are comprised of a myriad of tiny aluminum wires and electric switches, which manipulate the flow of electrical current. Electronic semiconductor processors are responsible for many of the steps necessary to manufacture each semiconductor that goes into a personal computer, missile guidance system, and a host of other electronic equipment.

Semiconductor processors manufacture semiconductors in disks about the size of dinner plates. These disks, called wafers, are thin slices of silicon on which the circuitry of the microchips is layered. Each wafer is eventually cut into dozens of individual chips.

Semiconductor processors make wafers using photolithography, a printing process for creating plates from photographic images. Operating automated equipment, workers imprint precise microscopic patterns of the circuitry on the wafers, etch out the patterns with acids, and replace the patterns with silicon and other materials. Then the wafers receive a chemical bath to make them smooth, and the imprint process begins again on a new layer with the next pattern. Wafers usually have from 8 to 20 such layers of microscopic, three-dimensional circuitry.

Semiconductors are produced in semiconductor fabricating plants, or “fabs”. Within fabs, the manufacture and cutting of wafers to create semiconductors takes place in “clean rooms.” Clean rooms are production areas that must be kept free of any airborne matter, because the least bit of dust can damage a semiconductor. All semiconductor processors working in clean rooms—both operators and technicians—must wear special lightweight outer garments known as “bunny suits.” Bunny suits fit over clothing to prevent lint and other particles from contaminating semiconductor processing worksites.

*Operators*, who make up the majority of the workers in clean rooms, start and monitor the sophisticated equipment that performs the various tasks during the many steps of the semiconductor production sequence. They spend a great deal of time at computer terminals, monitoring the equipment. They transfer wafer carriers from one development station to the next. Once begun, production of semiconductor wafers is continuous: Operators work to the pace of the machinery that has largely automated the production process. Operators are responsible for keeping the automated machinery at proper operating parameters.

*Technicians* account for a smaller percentage of the workers in clean rooms, but they trouble-shoot production problems and make equipment adjustments and repairs. They also take the lead in assuring quality control and in maintaining equipment. In order to prevent the need for repairs, technicians perform diagnostic analyses and run computations. For example, technicians may determine if a flaw in a chip is due to contamination and peculiar to that wafer, or if the flaw is inherent in the manufacturing process.

### Working Conditions

The work pace in clean rooms is deliberately slow. Limited movement keeps the air in clean rooms as free as possible of dust and other particles, which can destroy semiconductors during production. Because the machinery sets operators’ rate of work in the largely automated production process, workers keep an easy-going pace. Although workers spend some time alone monitoring equipment, operators and technicians spend much of their time working in teams.

Technicians are on their feet most of the day, walking through the clean room to oversee production activities. Operators spend a great deal of time sitting or standing at work stations, monitoring computer readouts and gauges. Sometimes, they must retrieve wafers from one station and take them to another. To minimize the risk of dropping expensive wafers and semiconductors, transportation of wafer carriers between work stations is usually automated.

The temperature in the clean rooms must be kept within narrow ranges, usually a comfortable 72 degrees Fahrenheit. The temperature inside bunny suits stays fairly constant as well. However, workers in bunny suits face some restrictions because entry and exit from each clean room are controlled to minimize contamination.



*An electronic semiconductor processor inspects the quality of the wafers containing microchips.*